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Memo

date: *Oct. 31, 2007*

to: *A. Ackerman*

from: *C. Weilandics* C. Weilandics

subject: *Bldg. 725 RF Equipment Survey (2007)*

This memo will summarize Radio-Frequency (RF) surveys conducted in the NSLS complex.

On May 4 , 2007, a partial RF survey was conducted by myself in Bldg. 725; in attendance was John Vaughn of the NSLS RF and Power Systems group. The purpose was to resurvey equipment which was surveyed back in 2001(re: Weilandics to Gmur, *Bldg. 725 RF Equipment Survey*, 1/3/02) to verify the status of potential for exposures to RF in Bldg. 725 from the high power RF equipment in use. As in the first survey, measurements were made on the following equipment summarized in the table I below:

1. Booster RF power amplifiers, idle and ramping, 52.8 MHz
2. VUV RF power amplifiers, powered, 211 MHz, stored beam
3. X-ray ring RF power amplifiers, 52.8 MHz, stored beam
   a) 100 watt amplifiers
   b) 3 kW power amplifiers
   c) 125 kW power amplifiers

For these measurements, electric (E) field surveys were conducted using a calibrated (Apr. 7, 2007) Narda 8718B Electromagnetic Radiation Survey meter. The E field probe (cal. Apr. 10, 2007) used is capable of measuring RF over the frequency ranges of 300 kHz to 50 GHz. The meter can be set to read out in a variety of units, however for the purpose of this survey it was set to read out in percent of standard. During the survey of the equipment, measurements were taken around the cabinets housing the equipment, specifically at the panel joints where one might expect some leakage. Also surveyed were the accessible portions of the RF cables and their connections, and waveguide joints. In addition to a general survey, for the cabinets, a spatial average was performed where an individual might be expected to stand, both in the front and rear of the racks. This spatial average is typically measured by scanning a planar area equivalent to the area occupied by standing adult human being (projected area). In most cases a simple linear vertical scan of the fields over a 2 m height will be sufficient. In our case, this consisted of an average reading of eight equally spaced points over this 2 meter height, again in front and back of the equipment being surveyed.

On May 7, 2007, the 2856 MHz RF systems for the NSLS Linac, Bldg. 725, were surveyed. These included the nominal 1 watt and 1kW signal drive for the first klystron housed in cabinet LSR15 near the LINAC gun, as well as the drive signals for each of the other two klystrons feeding off of the splitter from the #1 klystron waveguide. In addition, the waveguide feeds from klystrons 1, 2 and 3 into their respective Linac tanks up to their wall penetrations into the linac cave during VUV ring injection were measured. In all cases measurements were less than 1% of the standard.

On July 3, 2007, the 2856 MHz RF systems for the Source Development Laboratory, Bldg. 729, were surveyed which included the RF systems for the klystrons A, B; system C was not operating. These measurements included the single 5 Watt preamplifier feed signal and the 500 Watt amplifiers for systems A and B as well as the pulse forming network (PFN) cabinets for both systems. In all cases measurements were less than 1% of the standard. These surveys included all connections from the amplifier racks and PFN cabinets to the klystrons as well as the klystrons themselves.

Results

For this set of measurements, we found no appreciable (< 1% of the standard) RF from any of the systems.

Discussion

The standard for exposure to non-ionizing radiation which BNL has referenced is the IEEE C95.1-1999 standard also referenced by ACGIH. In all cases the electric field strength levels measured were well below the standard of 1 mW/cm^2. In referenced standard, induced and contact body current measurements are to be made if the electric field strength levels are above 18% (for the 52.8 and 211 MHz frequencies) of the TLV. In our case this was not exceeded. However, as stated above, these levels do not pose whole body exposures, and in no case was the Threshold Limit Value exceeded. The general TLVs for RF and microwaves are not expected to change. Based on this preliminary set of measurements, measured magnetic(H) fields are not expected to be significant, or in most cases measurable.

Table I: RF systems measured and conditions of measurement

Number	System Name	Power Rating	Fwd. Pwr.	Notes
1	XRF1	125 kW	86 kW	260-269mA, 2.8 GeV
2	XRF1	3 kW	2.2 kW	260-269mA, 2.8 GeV
3	XRF1	100 W	NR	260-269mA, 2.8 GeV
4	XRF2A	125 kW	67 kW	260-269mA, 2.8 GeV
5	XRF2A	3 kW	1.6 kW	260-269mA, 2.8 GeV
6	XRF2A	100 W	NR	260-269mA, 2.8 GeV
7	XRF2B	125 kW	63 kW	260-269mA, 2.8 GeV
8	XRF2B	3 kW	1.5 kW	260-269mA, 2.8 GeV
9	XRF2B	100 W	NR	260-269mA, 2.8 GeV
10	XRF3	125 kW	81 kW	260-269mA, 2.8 GeV
11	XRF3	3 kW	2 kW	260-269mA, 2.8 GeV
12	XRF3	100 W	50 W	260-269mA, 2.8 GeV
13	XRF4	125 kW	83 kW	260-269mA, 2.8 GeV
14	XRF4	3 kW	2 kW	260-269mA, 2.8 GeV
15	XRF4	100 W	NR	260-269mA, 2.8 GeV
16	VUVRF1	50 kW	16.7 kW	540-543 mA, 800MeV
17	VUVRF1	3 kW	300 W	540-543 mA, 800MeV
18	VUVRF1	100 W	NR	540-543 mA, 800MeV
19	VUVRF2	10 kW	590 W	540-543 mA, 800MeV
20	VUVRF2	10 W	NR	540-543 mA, 800MeV
21	Booster RF	3 kW		"Front porch"
22	Booster RF	3 kW		Ramping
23	Booster RF	100 W		"Front porch"
24	Booster RF	100 W		Ramping

NR: not recorded

Table I: RF systems measured and conditions of measurement (cont.'d)

Number	System Name	Power Rating	Fwd. Pwr.	Notes
25	SDL system A	See notes		set point @ 0.533
26	SDL system B	See notes		set point @ 0.548

Table II: RF equipment measured

SYSTEM	ITEM	MANUF.	MODEL	SERIAL#	RACK#	AREA
BOOSTER - 52.88 MHZ						
BRF	100W	IFI	M1600-52	093-2500	1193-SR9	1193
	3KW	BURLE/RCA	Y1378D		1193-SR11	1193
XRAY - 52.88MHZ						
XRF1	100W	IFI	M1600-52	0485-2738	1200-SR22	1200
	4KW	QEI	52MHZ	B/C 109153	1200-SR24	1200
	125W	EIMAC	CV-2232A	#00004	1200-SR29	1200
SPARE	3KW	BURLE/RCA	Y1378D		1200-SR21	1200
XRF2A	100W	IFI	M1600-52	0585-2749	1200-SR22	1200
	3KW	BURLE/RCA	Y1378D		1200-SR23	1200
	125W	EIMAC	CV-2232A	#00003	1200-SR6	1200
XRF2B	100W	IFI	M1600-52	0585-2753	1200-SR22	1200
	3KW	BURLE/RCA	Y1378D		1200-SR25	1200
	125W	EIMAC	CV-2232A	#00005	1200-SR4	1200
XRF3	100W	IFI	M1600-52	0485-0739	2122-SR2	2122
	3KW	BURLE/RCA	Y1378D		2122-SR3	2122
	125W	EIMAC	CV-2232A	#00001	2122-SR6	2122
XRF4	100W	IFI	M1600-52	0485-2737	2122-SR11	2122
	3KW	BURLE/RCA	Y1378D		2122-SR10	2122
	125W	EIMAC	CV-2232A	#00002	2122-SR7	2122
VUV - 52.99MHZ						
VUVRF-1	100W	ENI	3100LA	109	1003-SR3	1003
	3KW	BURLE/RCA	Y1378D		1003-SR4	1003
	50W	BURLE/RCA	Y1377D		1003-SR2	1003
VUV-211MHZ						
VUVRF2	10KW	QEI	211MHZ	A042439	10003-SR11	1003

Table II: RF equipment measured

Equip. Name	Manuf.	Model #	Serial #	Freq.	Oper. Pwr.	Room/Area
Klystron	Triton	8568	1117	2856MHz	15MWpk	725/LINAC
Klystron	Triton	8568	1110	2856MHz	15MWpk	725/LINAC
Klystron	RCA	4670	Y118	2856MHz	15MWpk	725/LINAC
Klystron	ITT	8568	1049	2856MHz	15MWpk	725/LINAC
Klystron A	Thompson	TH21288	128009	2856MHz	15MWpk	SDL
Klystron B	Thompson	TH21288	128014	2856MHz	15MWpk	SDL
Klystron C	Thompson	TH21288	128007	2856MHz	15MWpk	SDL
Preamplifier	Beta Development Corporation	5W	000002582	2856MHz	5W	SDL
Amplifier	Beta Development Corporation	500W	000002583	2856MHz	500W	SDL
Amplifier	Beta Development Corporation	500W	000002584	2856MHz	500W	SDL
Amplifier not measured (offline)	Beta Development Corporation	500W	000002585	2856MHz	500W	SDL

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